MASTER OF SCIENCE
IN
AERONAUTICAL ENGINEERING

ANALYSIS OF THE TIP LEAKAGE FLOW FIELD IN AN AXIAL TURBINE

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Comparisons of experimental laser Doppler velocimetry measurements using the Naval Postgraduate School cold-flow turbine test rig were made with 3D viscous computational fluid dynamics flow solutions. The turbine tested was the first stage of the Pratt and Whitney designed Space Shuttle Main Engine High Pressure Fuel Turbopump. The laser anemometer was modified to incorporate a field stop, which acted as a spatial filter to limit reception of undesired blade reflections. The laser measurements were made in the endwall region of the test turbine, at three axial locations, and at three radial depths. For each location, absolute flow angle, axial and tangential velocity ratios, turbulence intensities, and correlation coefficients were measured. The computational effort encompassed modeling a single blade passage of both the stator and the rotor and computing flow solutions of the stage using NASA software. Exit plane and endwall flow property profiles showed good agreement when compared with experimental data. A quasi-three-dimensional flow analysis of stator wake/rotor flow interaction was completed to investigate the unsteady effects neglected when "plane averaging" flow properties between grids during the full three-dimensional simulation.

DoD KEY TECHNOLOGY AREA: Aerospace Propulsion and Power

KEYWORDS: Laser Doppler Velocimetry, Computational Fluid Dynamics, Turbine Endwall Flow Analysis

A COMPUTATIONAL AND EXPERIMENTAL INVESTIGATION OF A FLUTTER GENERATOR

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The phenomenon of flutter is well known to aircraft designers. A fluttering wing on an aircraft absorbs a significant amount of energy from the air-stream. In this study, computational and experimental methods are used to investigate the possibility of extracting power from a flow using an oscillating airfoil. A numerical analysis is conducted using an unsteady panel code based on potential flow theory. Through the numerical study the combination of parameters is determined that results in the optimum performance of an oscillating-wing power generator. An experimental oscillating-wing power generator is described and tested in a water tunnel. Power and efficiency measurements from the generator are compared to the numerical results. Similar trends between the results suggest that an oscillating-wing power generator is capable of performance comparable to windmills and is a potential source of alternative power.

DoD KEY TECHNOLOGY AREAS: Aerospace Propulsion and Power, Air Vehicles, Other (Power Generation)

KEYWORDS: Aeroelasticity, Flutter, Flutter Generator, Power Generation, UPOT, Wingmill